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Soil nutrients with special health reference tozincby using RS and GIS in and around Wellington reservoir, Tittagudi taluk, Cuddalore district, Tamilnadu, India.

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ABSTRACT: *Zinc is involved in membrane integrity, enzyme activation, and gene expression. Rice, sorghum and corn are Zn sensitive. Keeping these problems in the view, recently development of micronutrient efficient genotypes, creating awareness of micronutrient dose, crop specific micronutrient uptake and accumulation are vital to improve productivity and to address human health problems.Thirty surface soil samples representing thirty villages of the recently thane cyclone affected areas of Tittagudi taluk, part of Nallur and Vriddhachalam taluk, cuddalore district of Tamilnadu in India. Soil samples were analyzed for the distribution pattern of basic soil parameters viz., pH, EC and the available micronutrient (DTPA extractable) Zinc was investigated by using Atomic Absorption Spectrophotometer (ECIL, AAS-4129). The Zinc status and their relationship with soil properties were also studied. The mapping of available nutrient status by GIS technique indicated that majority of the area was low to medium with respect to available pH, EC and Zinc. Among the micronutrients, zinc was the major constraint followed by other micronutrients and the selected area wasrich in cupper and manganese content.*

Keywords: *DTPA, GIS, micronutrients, soil properties, Remote Sensing, Zinc.*

I. INTRODUCTION

Heavy metals such as Zn are classified among the most dangerous groups ofenvironmental pollutants due to their toxicity and persistence in the environment [1], [2], [3].Researches carried out by some environmental scientists have revealed that the occurrence andgeographical distribution of certain diseases could be correlated with the presence of toxicelements in the geologic environment [4]. In view of that, it is critical to continually assess andmonitor the levels of metals species in soils due to mining activities, for the evaluation of humanexposure and for sustainable environment.Zinc found in varying concentrations in all soils, plants and animals and it is essential for the normal healthy growth of higher plants, animals and humans. Zinc is needed in small but critical concentrations and if the amount available is not adequate, plants and/or animals will suffer from physiological stress brought about by the dysfunction of several enzyme systems and other metabolic functions in which zinc plays a part zinc (Zn) are essential micronutrients for plants and humans [5],[6]. Micronutrient deficiency, especially Zn deficiency, is widespread in humans [7],[8],[9],[10]. Zinc is essential for the normal healthy growth and reproduction of plants, animals and humans and when the supply of plant-available zincis inadequate, crop yields are reduced and the quality of crop products is frequently impaired. The different types of symptoms vary with plant species and are usually only clearly displayed in severely deficient plants and Zinc-deficient soils causing hidden deficiency may remain undetected for many years unless soil or plant diagnostic tests are carried out, because there are no obvious signs of stress in the crops growing on them. However, a change to growing less zinc deficiency tolerant crop species or cultivars, or the adoption of more intensive farming methods may lead to the development of a more severe deficiency in the crop accompanied by visible symptoms which will bring the problem to the notice of the farmer. In cases of marginal deficiency, plant yields can often be reduced by 20% or more without obvious visible symptoms. This is called 'hidden', 'latent' or 'subclinical' deficiency. In this paper we discussed the importance of zinc in agriculture and their role in crop plants and ways to improve the crop productivity as well as human health through remote sensing and GIS.

II. STUDY AREA

The study area considered is Wellington reservoir watershed which is located in the Tittakudi taluk. It lies between the longitudes of 11˚21' to 11˚31' E and latitudes of 77˚28' to 77˚57'N "Fig 1". Tittagudi is a panchayat town and taluk headquarter of Cuddalore district, Tamilnadu, India. As of 2001 India Census, Tittagudi had a population of 20,734. In this taluk, agriculture area is 823.74 km^2 and mean annual rainfall is 1110 mm. Black soil is the predominant soil type in this area and main occupation of the area is agriculture. The groundwater level of the study area ranges from 2 m to 8 m bgl (below ground level). The Reservoir is located in Vellar Basin across a tributary stream PeriyaOdai of Vellar River. It receives Regulated Supply diverted from Vellar River at Tholudur Regulator and an additional catchment area of 129 $(km)^2$ of its own during North East Monsoon. The Reservoir was constructed during 1913-1923 and irrigates an ayacut of 11,200 Hectare. Paddy, Sugarcane are the major crops grown in and around wellington ayacut. The Reservoir was formed with available earth at site which was not suitable for the formation of Reservoir such formation with nonsuitable soil leads lot of problems such as slips etc., year by year.

METHODS

Soil samples (0-20 cm depth) were collected from 30 sites from the distance of every 5 km interval. "Fig. 1" covering 30 revenue villages, keeping in view the physiographic characteristic in different cross sections of the area as well as variation in soil texture. The list of villages of sampling sites of Tittakudi Taluk soils are highlighted in Fig 1. The names of the sampling stations are given below in correspondence to the number on the map. The processed soil samples were analyzed for basic soil parameters (pH, EC and calcium carbonate) .The available Zn in soil samples were extracted with a DTPA solution (0.005 M DTPA + 0.01 M CaCl2 + 0.1M triethanolamine, pH 7.3) as outlined by [11]. The concentration of micronutrients in the extract was determined by atomic absorption spectrophotometer (ECIL, AAS-4129)

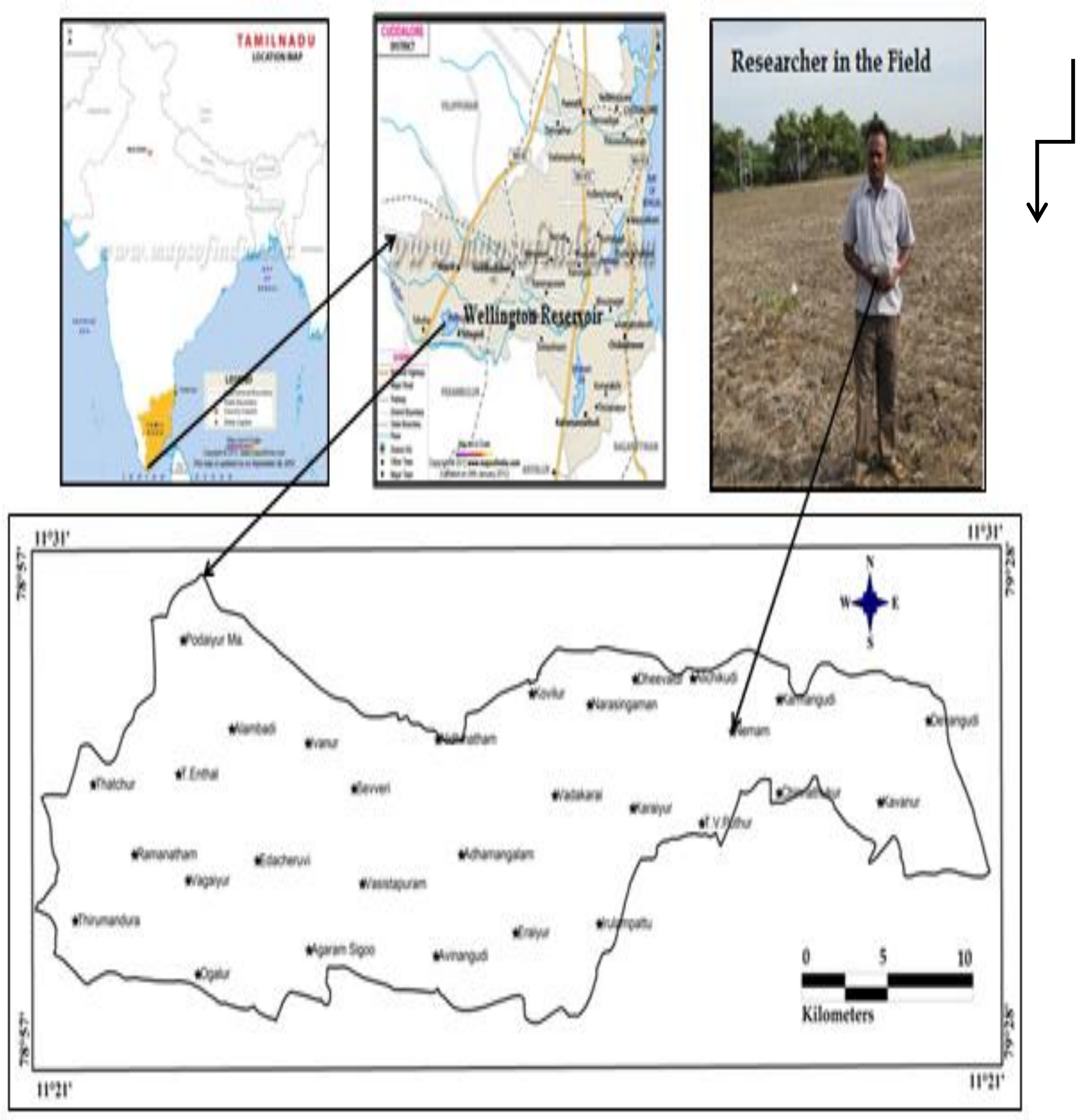
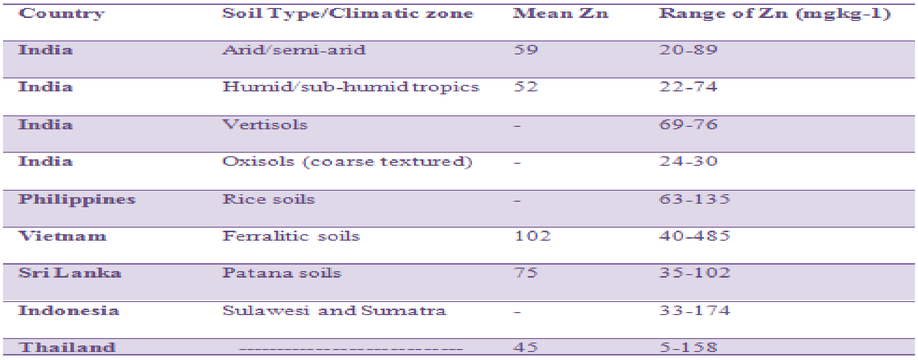


Fig.1.Location map of the study area

III. RESULTS AND DISCUSSION

Factors Controlling the Total Zinc Content of Soils

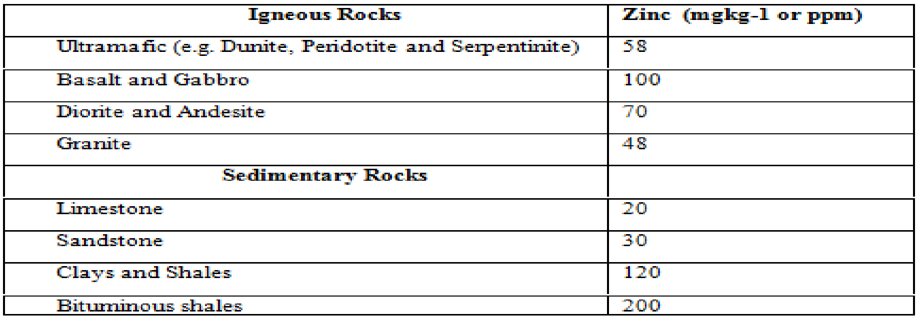
Table: 1. Means and Ranges of Total Zinc Concentrationsin Soils from Tropical Asia[12]



Country	Soil Type/Climatic zone	Mean Zn	Range of Zn (mgkg-1)
India	Arid/semi-arid	59	20-89
India	Humid/sub-humid tropics	52	22-74
India	Vertisols	-	69-76
India	Oxisols (coarse textured)	-	24-30
Philippines	Rice soils	-	63-135
Vietnam	Ferralitic soils	102	40-485
Sri Lanka	Patana soils	75	35-102
Indonesia	Sulawesi and Sumatra	-	33-174
Thailand	------------------------------	45	5-158

The values given in “Table 1” show similar mean values and ranges for zinc in the soils of these Asian countries as are found in European and north American soils. However,total contents do not provide a good indication of the concentrations available to plants except that soils with very low total concentrations are more likely to be deficient than those with higher concentrations.The clear trend of low concentrations in sandy soils and higher zinc concentrations in soils with larger clay contents. This is a consequence of both the higher zinc concentrations in clay and shale parent materials and also the greater ability of clay-rich soils to adsorb and retain zinc and other elements relative to soils with lower percentages of clay and higher percentages of sand. Sandy soils all over the world are often found to have low, or deficient, zinc concentrations for crops. It is important to stress that in many parts of the world, soils tend to be very heterogeneous in their distribution, especially in areas affected by glacial and periglacial processes with a wide range of soils developed on drift deposits. Patches of sandy soil of low zinc and other nutrient element status can often be found amongst more clay-rich soils with adequate levels of available micronutrients.

Table 2.Average Concentrations of Zinc in the Major Types of Rock (mgkg-1or ppm) [13], [14].



Igneous Rocks	Zinc (mgkg-1 or ppm)
Ultramafic (e.g. Dunite, Peridotite and Serpentinite)	58
Basalt and Gabbro	100
Diorite and Andesite	70
Granite	48
Sedimentary Rocks	
Limestone	20
Sandstone	30
Clays and Shales	120
Bituminous shales	200

In “Table 2”, the higher concentrations of zinc shown for the basic igneous rocks, such as basalts are due to zinc occurring in ferromagnesian minerals including augite, hornblende and biotite, where it has been isomorphously substituted for Fe^{2+} or Mg^{2+} which are the principal components of the crystal lattice, along with silicon, aluminium and oxygen. More silica-rich igneous rocks, such as granites and metamorphic rocks including gneiss have much lower total zinc contents and their residual weathering product is usually quartz sand which gives rise to either sandy soils or sandy sediments which undergo diagenesis and form sandstone sedimentary rocks with low concentrations of zinc and other essential micronutrients.

The main parameters controlling the interactions of zinc are:

i) the concentration of Zn^{2+} and other ions in the soil solution,

ii) the type and amount of adsorption sites associated with the solid phase of the soil,

iii) the concentration of all ligands capable of forming organo-zinc complexes,

iv) pH and redox potential of the soil.

IV. FACTORS AFFECTING THE AVAILABILITY OF ZINC IN SOILS TO PLANTS

The zinc which is available to plants is that present in thesoil solution, or is adsorbed in a labile (easily desorbed)form. The soil factors affecting the availability of zinc toplants are those which control the amount of zinc in thesoil solution and its sorption-desorption from/into the soilsolution. These factors include: the total zinc content, pH,organic matter content, clay content, calcium carbonatecontent, redox conditions, microbial activity in the rhizosphere,soil moisture status, concentrations of other traceelements, concentrations of macro-nutrients, especiallyphosphorus and climate.

Some of these factors are briefly summarized here in a practical crop production context:

Sandy soils and acid highly leached soils with low total and plant-available zinc concentrations are highly prone to zinc deficiency. Availability of zinc decreases with increasing soil pH due to increased adsorptive capacity, the formation of hydrolysed forms of zinc, possible chemisorption on calcium carbonate and coprecipitation in iron oxides. Alkaline, calcareous and heavily limed soils tend to be more prone to zinc deficiency than neutral or slightly acid soils.When rapidly decomposable organic matter, such as manure, is added to soils, zinc may become more available due to the formation of soluble organic zinc complexes which are mobile and also probably capable of absorption into plant roots. Available zinc concentrations in soils with high organic matter contents (peat and muck soils) may be low due to either an inherently low total concentration in these organic materials and/or due to the formation of stable organic complexes with the solid-state organic matter.High levels of phosphorus may decrease the availability of zinc or the onset of zinc deficiency associated with phosphorus fertilization may be due to plant physiological factors. Some forms of phosphatic fertilisers, such as superphosphate, contain significant amounts of zinc as impurities and also have an acidifying effect on soils. When these are replaced with "high analysis" forms of phosphatic fertilisers, such as monoammonium phosphate (MAP) and diammonium phosphate (DAP) the incidence of zinc deficiency has often been found to increase.Higher concentrations of copper in the soil solution, relative to zinc, can reduce the availability of zinc to a plant (and *vice versa*) due to competition for the same sites for absorption into the plant root. This could occur after the application of a copper fertiliser. In waterlogged soils, such as paddy rice soils, reducing conditions result in a rise in pH, high. Table 3 is useful for comparing sensitivity to deficiency and response to zinc fertilisers; it does not indicate the extent to which these crops are affected by zinc deficiency in various parts of the world.

Table: 3.Relative Sensitivity of Crops to Zinc Deficiency [15], [16].

High	Medium	Low
Bean	**Barley**	**Alfalfa**
Citrus	**Cotton**	**Asparagus**
Flax	**Lettuce**	**Carrot**
Fruit trees (deciduous)	**Potato**	**Clover**
Grapes	**Soybean**	**Grass**
Hops Sudan grass Oat	**Sudan grass**	**Oat**
Maize (corn)	**Sugar beet**	**Pea**
Onions	**Table beet**	**Rye**
Pecan nuts	**Tomato**	**Wheat**
Rice		
Sorghum		
Sweet corn		

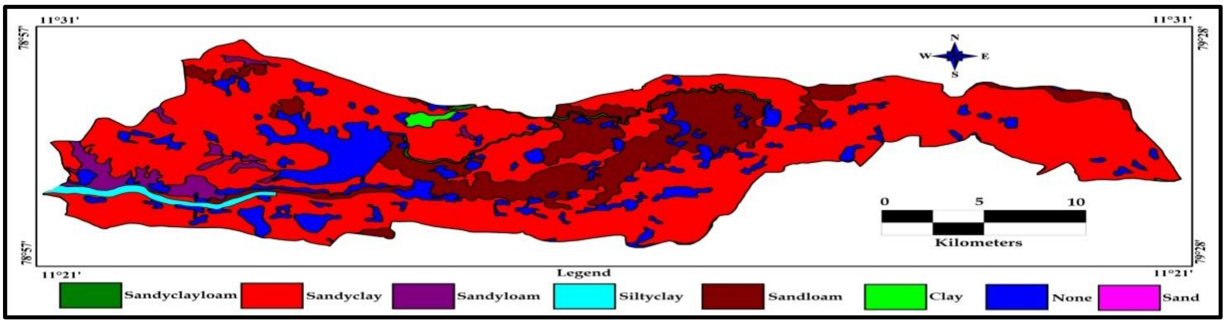


Fig: 2. Soil textural map of the Study area

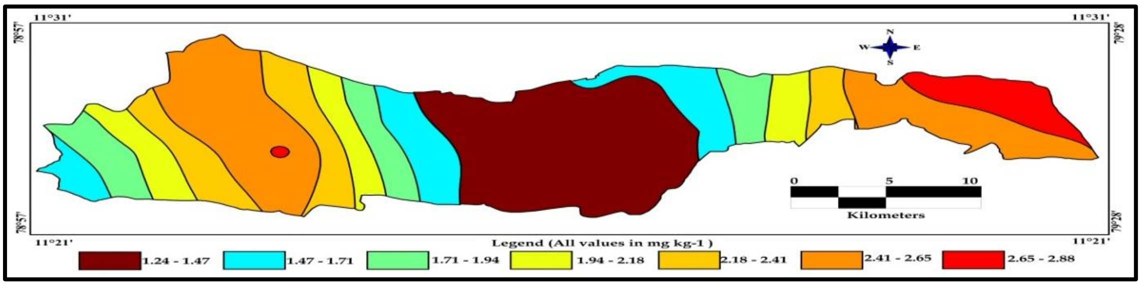


Fig: 3. Spatial distribution of the Zinc Concentration map

Table 4.Permissible limit of Zinc in soil [17].

Zinc Range	Status	Sample number
<0.6	**Deficit**	**nil**
0.6-1.2	**Marginal**	**8, 14, 15, 17, 24**
1.2-2.4 &>2.4	**Sufficient**	**1-7,9-13,16,18-23,25-30**

Table 5.Availability of Zinc from Different Types of Diets [18].

Availability of Zinc	Type of Diet
High	**Refined diets low in fibre, low in phytate (phytate:zinc molar ratio < 5), adequate protein mainly from non-vegetable sources.**
Moderate	**Mixed diets containing animal or fish protein, lacto-ovo, ovovegetarian diets not based primarily on unrefined cereal grains or high extraction flours. Phytate: zinc molar ratios 5-15 or not exceeding 10 if more than 50% of energy is from unfermented, unrefined cereal grains and flours. Availability of zinc improves**
Low	**Diets high in unrefined, unfermented, and ungerminated cereal grain, especially when fortified with calcium salts and intake of animal protein is negligible. Phytate:zinc molar ratio is >15. Diets in which 50% of the energy is in high phytate foods including: high extraction rate flours of wheat, rice, maize, grain and flours, oatmeal and millet, chapatti flours and tanok, sorghum, cowpeas, pigeon peas, grams, kidney beans, blackeye beans, and groundnut flours, and high intakes of inorganic Calcium salts.**

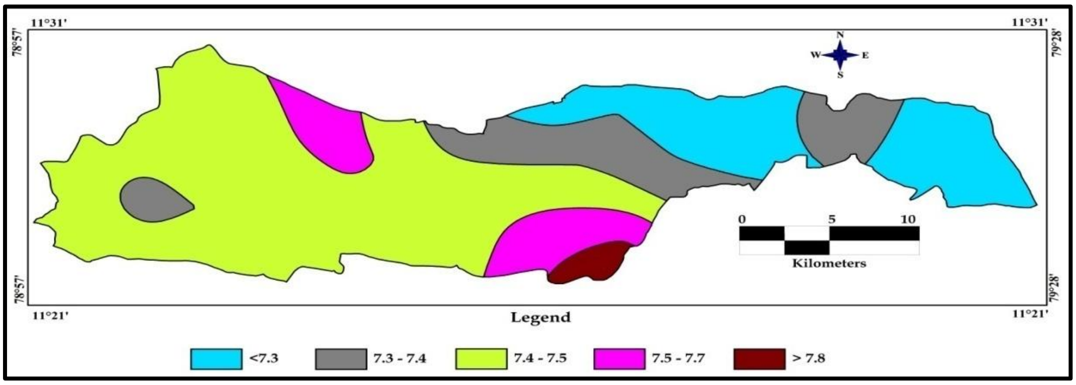


Fig:4.Spatial distribution of the pH Concentration map

The results of the determination of the Zn concentration in the sand loam and sandclay soils are presented on fig 3. The variation of the studied metals in the sampled soils is also depicted in “Table 5”. The potential for zinc toxicity can be reduced or eliminated by liming the soil to raise the water pH above 6.0 or 6.5, the pH level normally recommended for the crop growing or to be grown. Plants are particularly sensitive to zinc and this element can be toxic to plants at combinations of soil pH and extractable zinc “fig.3” and “fig.4”. Soils with these combinations of soil pH and extractable zinc should be planted to another crop. Zinc toxicity can occur for other crops at levels of greater than 40 lbs per acre. Zinc exists in the soil solution as the zinc (Zn^{2+}) cation “Table .5”.

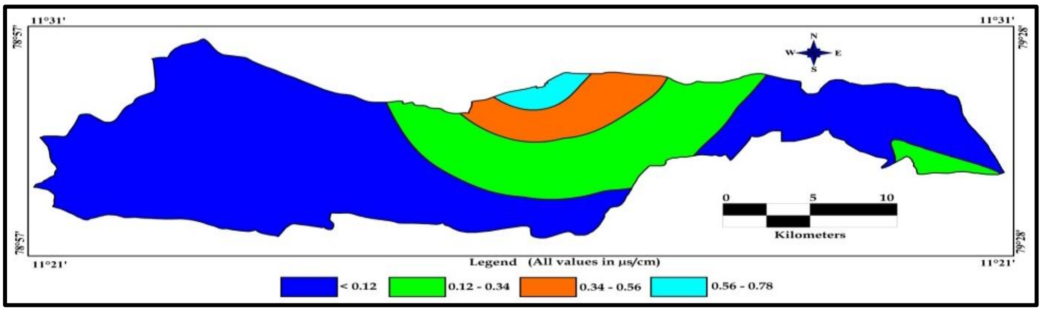


Fig 5. Spatial distribution of the EC Concentration map

Table 5: combinations of soil pH and extractable zinc

Soil pH	Extractable Zinc lbs per acre
< 5.9	**> 5**
< 6.0	**> 11**
< 6.1	**> 21**
< 6.2	**> 31**
< 6.3	**> 41**
> 6.2	**> 51**

IV. CONCLUSIONS

Zinc deficiency is leads to crop yieldlosses and human health problem.Importance ofmicronutrient in agriculture systems have beenrealized middle of 20th century but not intensivelyyet practiced in many crops. To improvezinc in crop produces focused researchon, to evolve high micronutrient responsive variety,plant and soil diagnostic kits, soil and cropspecific management studies to be carried out.Effective outreach to farmers to adopt recommendationwill improve crop productivity, quality of crop produce and improve the Znavailability to human and animals.

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